

06/00273 Quantitative study of creep cavity area of HP40 furnace tubes

Guan, K. *et al. Nuclear Engineering and Design*, 2005, 235, (14), 1447–1456.

Ethylene cracking tubes of HP40 grade (25Cr–35Ni–0.4C) creep-resistant austenitic steel which failed after 80,000 h service were investigated for quantitative cavity evaluation. The results show that the creep cavity area fractions (Ω) present little difference from outer surface to inner surface through the thickness, and larger difference on different tube outer surfaces. The Ω obtained from the outer surface can stand for creep damage state for ethylene cracking tubes. The relationship between creep cavity area fraction and continuum damage mechanics is discussed. At failure, the critical value of damage variable $D = 1$ is corresponding to $\Omega = 2.8\%$ measured on the tube outer surface.

06/00274 Self-ignition of a lean mixture of *n*-pentane and air over a wide range of pressures

Zhukov, V. P. *et al. Combustion and Flame*, 2005, 140, (3), 196–203.

The shock-tube technique is used to measure the ignition delay time of a lean ($\phi = 0.5$) mixture of *n*-pentane and air in a wide range of temperatures from 867 to 1534 K and pressures from 11 to 530 atm. The previously developed detailed kinetic model of ignition of hydrocarbons is used to interpret the experimental data. The kinetic model includes mechanisms of ignition at high and low temperatures and a mechanism of ignition in the range of intermediate (1000–1200 K) temperatures. Each of these mechanisms is analysed. The effect of the mixture pressure on the ignition at a temperature of 1000–1100 K is demonstrated.

06/00275 Soot concentration and temperature measurements in co-annular, nonpremixed CH₄/air laminar flames at pressures up to 4 MPa

Thomson, K. A. *et al. Combustion and Flame*, 2005, 140, (3), 222–232. Laminar non-premixed methane–air flames were studied over the pressure range of 0.5 to 4 MPa using a new high-pressure combustion chamber. Flame characterization showed very good flame stability over the range of pressures, with a flame tip *rms* flicker of less than 1% in flame height. At all pressures, soot was completely oxidized within the visible flame. Spectral soot emission (SSE) and line-of-sight attenuation (LOSA) measurements provided radially resolved measurements of soot volume fraction and soot temperature at pressures from 0.5 to 4.0 MPa. Such measurements provide an improved understanding of the influence of pressure on soot formation and have not been reported previously in laminar non-premixed flames for pressures above 0.4 MPa. SSE and LOSA soot concentration values typically agree to within 30% and both methods exhibit similar trends in the spatial distribution of soot concentration. Maximum soot concentration depended on pressure according to a power law, where the exponent on pressure is about 2 for the range of pressures between 0.5 and 2.0 MPa, and about 1.2 for 2.0 to 4.0 MPa. Peak carbon conversion to soot also followed a power-law dependence on pressure, where the pressure exponent is unity for pressures between 0.5 and 2.0 MPa and 0.1 for 2.0 to 4.0 MPa. The pressure dependence of sooting propensity diminished at pressures above 2.0 MPa. Soot concentrations measured in this work, when transformed to line-integrated values, are consistent with the measurements of others. Soot temperature measurements indicate that the overall temperatures decrease with increasing pressure; however, the differences diminish with increasing height in the flame. Low down in the flame, temperatures are about 150 K lower at pressures of 4.0 MPa than those at 0.5 MPa. In the upper half of the flame the differences reduce to 50 K.

10 ENGINES

Power generation and propulsion, electrical vehicles

06/00276 Artificial neural-network based modeling of variable valve-timing in a spark-ignition engine

Gölcü, M. *et al. Applied Energy*, 2005, 81, (2), 187–197.

Variable valve-timing and lift are significant operating and design parameters affecting the performance and emissions in spark-ignition (SI) engines. Previous investigations have demonstrated that improvements in engine performance can be accomplished if the valve timing is variable. Traditionally, valve timing has been designed to optimize

operation at high engine-speed and wide-open throttle conditions. Controlling valve timing can improve the torque and power curve of a given engine. Variable valve-timing can be used to reduce fuel consumption and increase engine performance. Intake valve-opening timing was changed from 10° crankshaft angle (CA) to 30° CA for both advance and retard with 10° CA intervals to the original opening timing. In this study, artificial neural-networks (ANNs) are used to determine the effects of intake valve timing on the engine performance and fuel economy. Experimental studies were completed to obtain training and test data. Intake valve-timing and engine speed have been used as the input layer; engine torque and fuel consumption have been used as the output layer. For the torque testing data, root mean squared-error (RMSE), fraction of variance (R^2) and mean absolute percentage error (MAPE) were found to be 0.9017%, 0.9920% and 7.2613%, respectively. Similarly, for the fuel consumption, RMSE, R^2 and MAPE were 0.2860%, 0.9299% and 7.5448%, respectively. These results suggest that the ANN can be used for the prediction of engine performance as an appropriate method for spark-ignition (SI) engines.

06/00277 Beta-type Stirling engine operating at atmospheric pressure

Cinar, C. *et al. Applied Energy*, 2005, 81, (4), 351–357.

In this study, a beta-type Stirling engine, with a 192 cc total swept-volume, was manufactured and its performance tested at atmospheric pressure. The hot-source temperature is chosen as a fundamental parameter of the experimental study. Experiments were performed with an electrical heater at 800, 900 and 1000°C temperatures. Torque and output-power variations were obtained for different engine speeds. The test engine reached a maximum of 5.98 W at 208 rpm, at the hot-source temperature of 1000°C.

06/00278 Comparative study of some experimental methods to characterize the combustion process in a SI engine

Zervas, E. *Energy*, 2005, 30, (10), 1803–1816.

Seven common methods based on in-cylinder data, usually applied to determine the combustion parameters (ignition delay and combustion duration), are compared using in-cylinder data provided from a natural gas spark ignition engine operating under lean conditions. The influence of three engine-operating parameters: spark advance, throttle opening and fuel/air equivalence ratio, on combustion parameters are tested using every method and the results are compared. The application of these methods on average and individual cycles is also performed. The advantages and disadvantages of these methods are presented and discussed. Some methods can be used only for the ignition delay determination. A comparison with a motor-cycle, so a specific experimental device, is necessary for three methods. Others are very sensitive to noise, or can be used only in some restricted area of engine operating conditions. One method needs calculations based on several experimental assumptions.

06/00279 Correlations between cycle-to-cycle variations and combustion parameters of a spark ignition engine

Zervas, E. *Applied Thermal Engineering*, 2004, 24, (14–15), 2073–2081.

The coefficient of covariation (COV) of the in-cylinder pressure is determined on each crank angle of a number of cycles, in the case of a natural gas feed SI engine operating under lean conditions. The resulting curve of COV versus crank angle is explored. Its shape is independent of the experimental conditions and it is always the same for all the experimental points used. Three points of this curve show particular interest, as they correspond to the combustion beginning, combustion end and the point where the mass burned fraction is 50% (half combustion duration). The hypothesis concerning the combustion limits is proved by the comparison of the COV curves of fired and motored cycles and by the determination of the combustion beginning and end using different methods. The hypothesis of the half combustion duration point is verified from a burn rate analysis of the cycle. The integral of the COV curve in the combustion region is proposed as a criterion of the cyclic dispersion quantification. The integrals of the first and second combustion periods are explored as a function of the engine operating parameters.

06/00280 Effect of input energy on the emission of a motorcycle engine with an electrically heated catalyst in cold-start conditions

Hornig, R.-F. and Chou, H.-M. *Applied Thermal Engineering*, 2004, 24, (14–15), 2017–2028.

Experimental investigation on the cold-start condition of an electrically heated catalyst of a four-stroke motorcycle engine was carried out at idle operation. The effects of input energy from heaters and unburnt gas oxidation on the exhaust temperature and the exhaust emission were investigated. Apart from heating temperature and the CO setting level, the other studied parameters included the heating position and input energy. The heating temperatures included 100, 140 and 180°C and the CO levels were set as 1.0%, 1.3%, 1.8% and 2.3%. Six different